

Total Maximum Daily Load Studies in Receiving Waters in Accomack County

Public Meeting
March 28, 2012

Why We Are Here

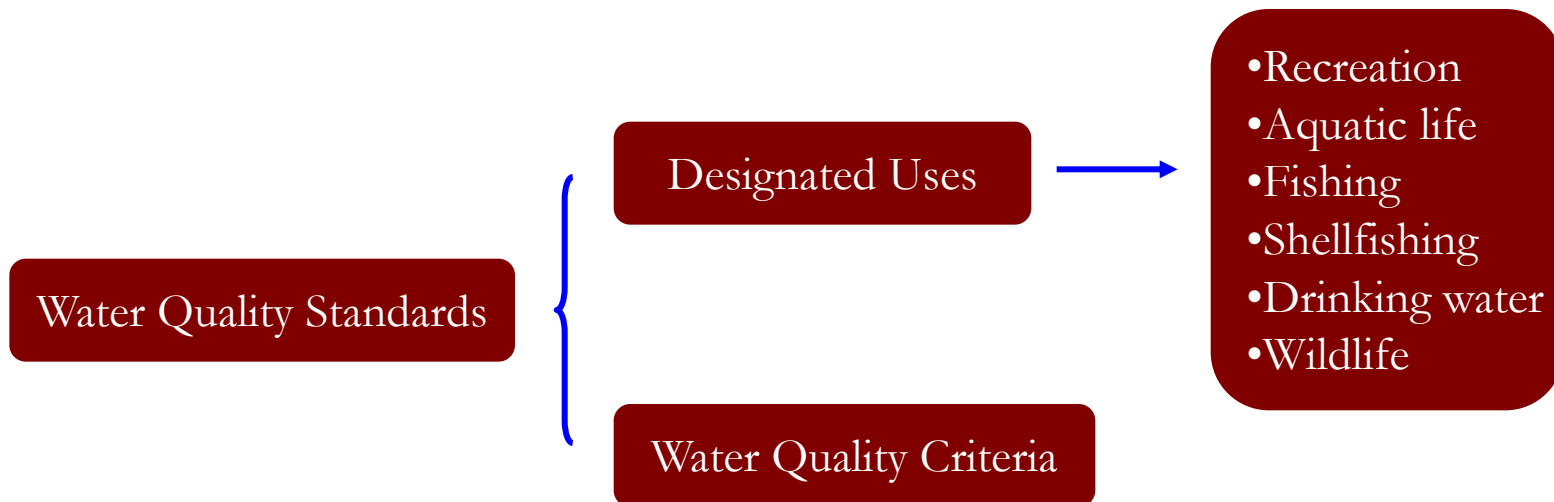
1. To learn about water quality of the stream
2. To discuss the Total Maximum Daily Load (TMDL) development
3. To gather comments and encourage public participation

Outline

- The TMDL Process
- Impaired Waters and Pollutants
- Procedures of pollutant source assessment
- Developed modeling approach
- Preliminary TMDL results
- Comments

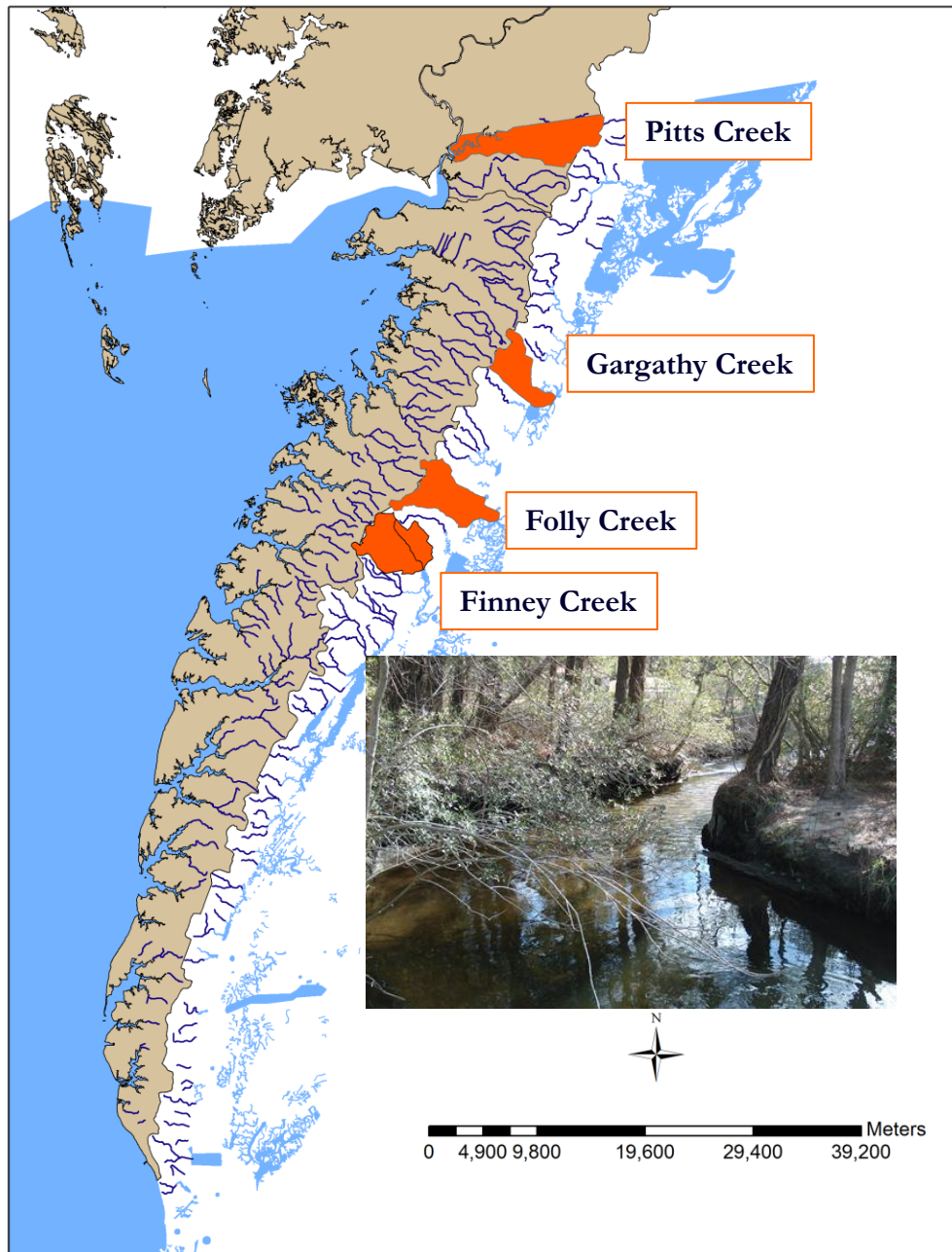
The TMDL Process

- DEQ routinely monitors the quality of waters across the state and publishes a list of impaired waters every 2 years
- Virginia is required by law to establish a TMDL for each pollutant causing an impairment
- A TMDL is the amount of a particular pollutant that a stream can receive and still meet Water Quality Standards



Impaired Waters and Pollutants

- Unnamed tributary to Pitts Creek (bacteria and pH)
- Gargathy Creek
 - Upper and lower estuarine portioan (dissolved oxygen)
 - Riverine portion (bacteria)
- Folly Creek
 - Folly Creek-Upper, middle, and unnamed tributary to Folly Creek (dissolved oxygen)
 - Folly Creek-Upper and middle (bacteria)
- Finney Creek-Upper (bacteria)



Pitts Creek



Gargathy Creek



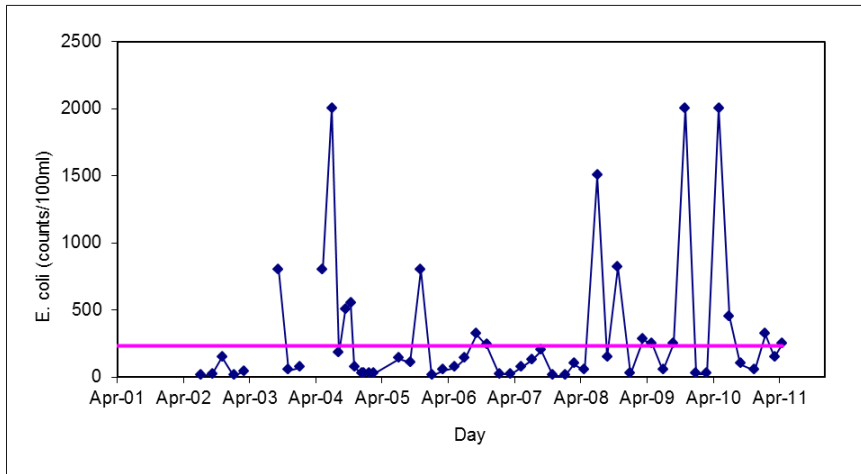
Folly Creek

Water Quality Criteria

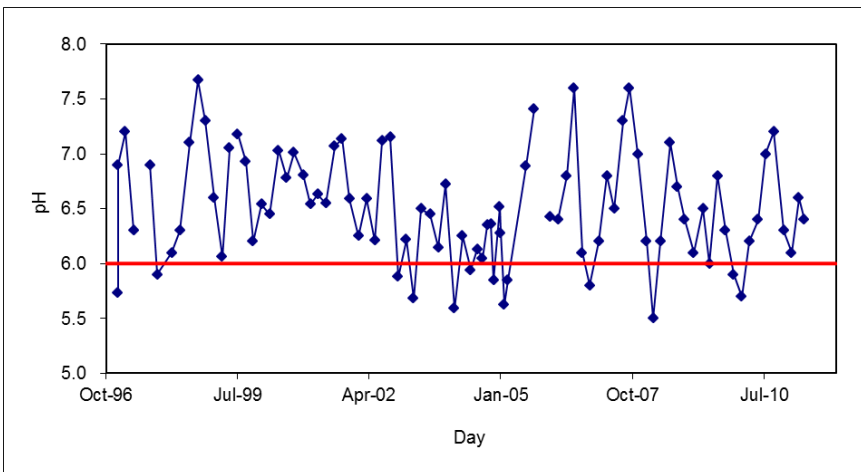
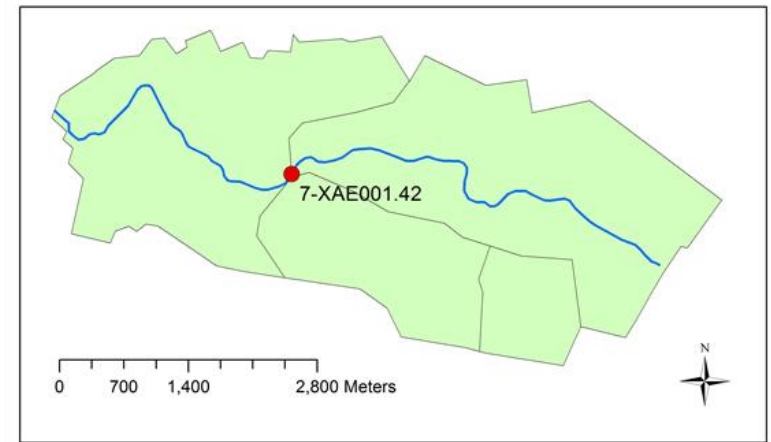
Water Type		Criteria
Class II (tidal water)	Dissolved oxygen	Minimum: 4 mg/l; Daily Average: 5 mg/l
Class III (freshwater)	E. Coli (freshwater)	Geomean 126 counts/100ml Single Sample Max. 235 counts/100ml
	Enterococci (salt water)	Geomean 35 counts/100ml Single Sample Max. 104 counts/100ml
	pH	6 - 9

Violation Verification

Pitts Creek



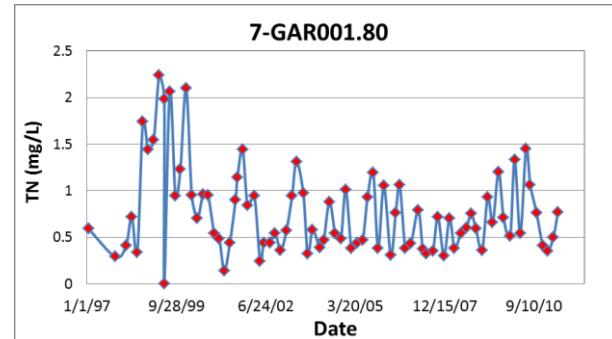
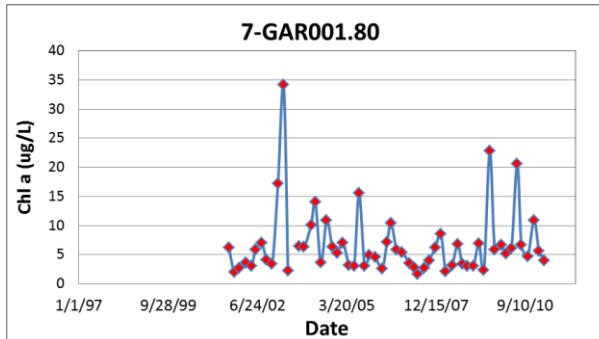
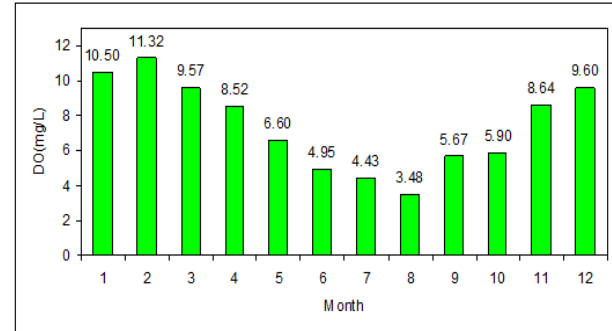
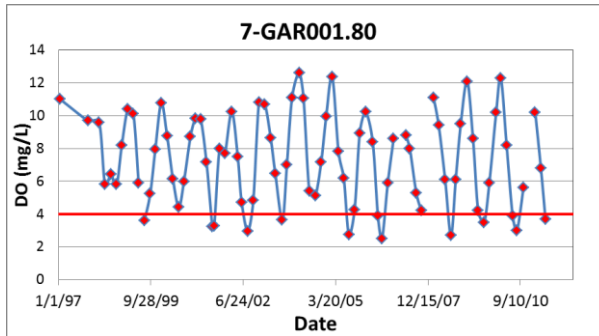
Violation 33%



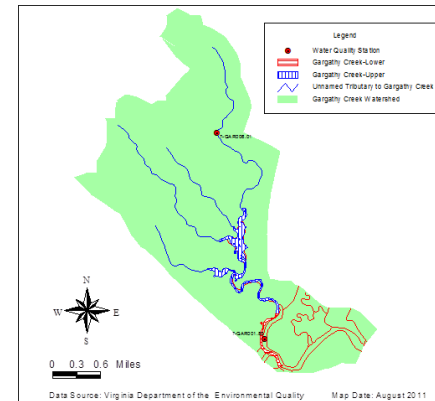
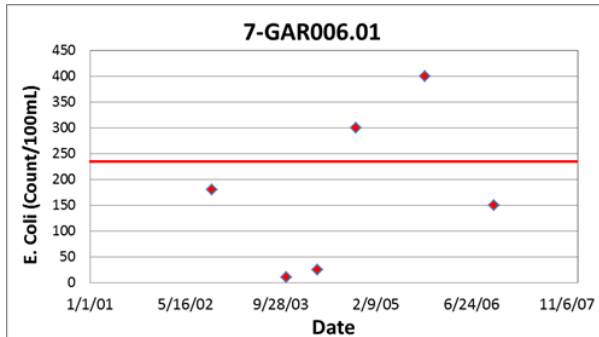
Violation 17%

Gargathy Creek

Violation
=16.2%

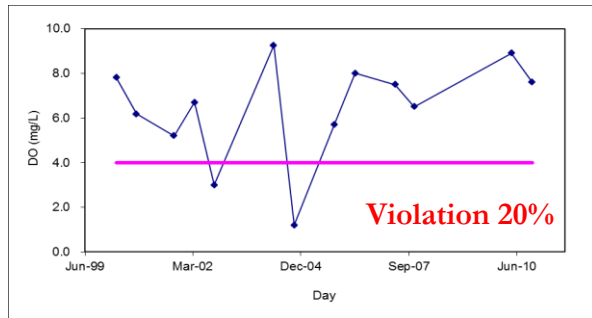


Violation
=33.3%

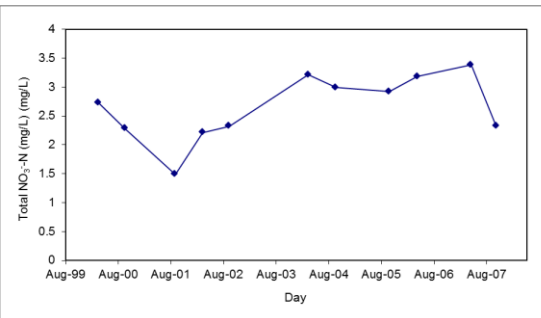


Folly Creek

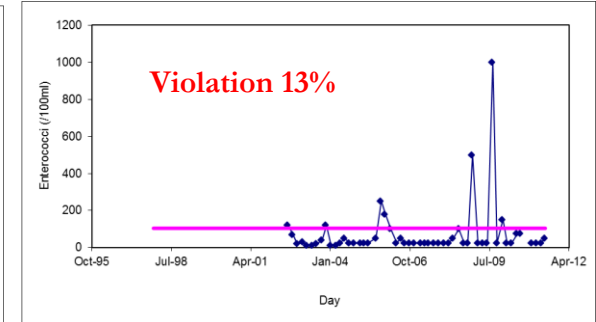
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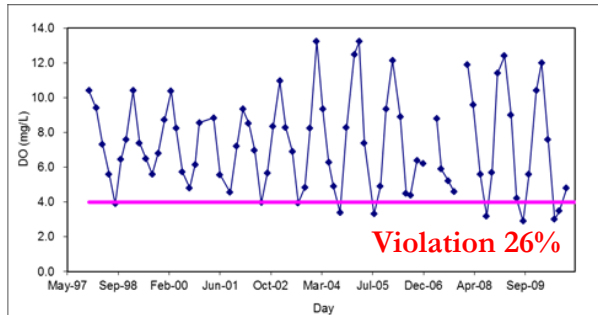
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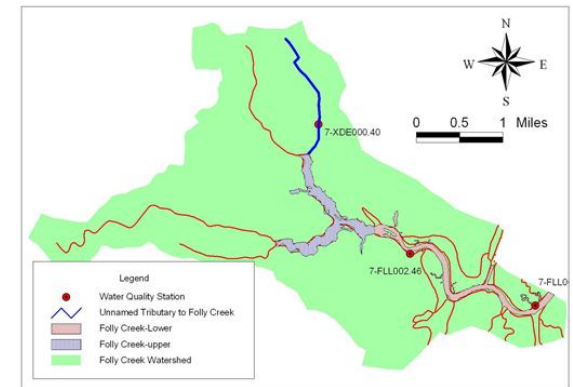
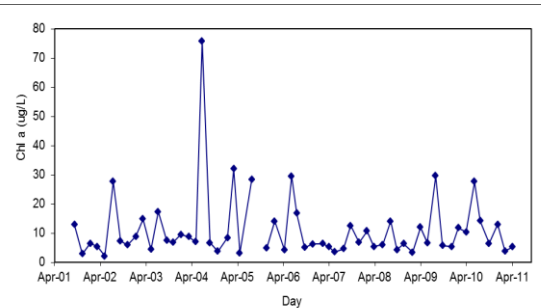
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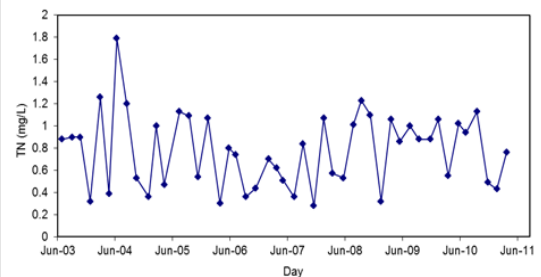
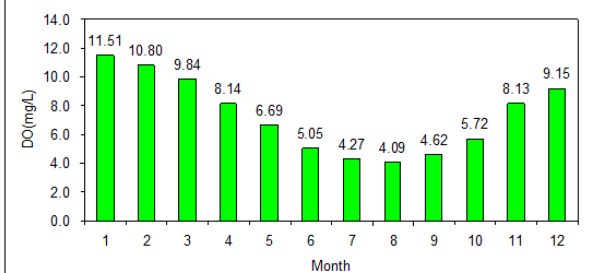
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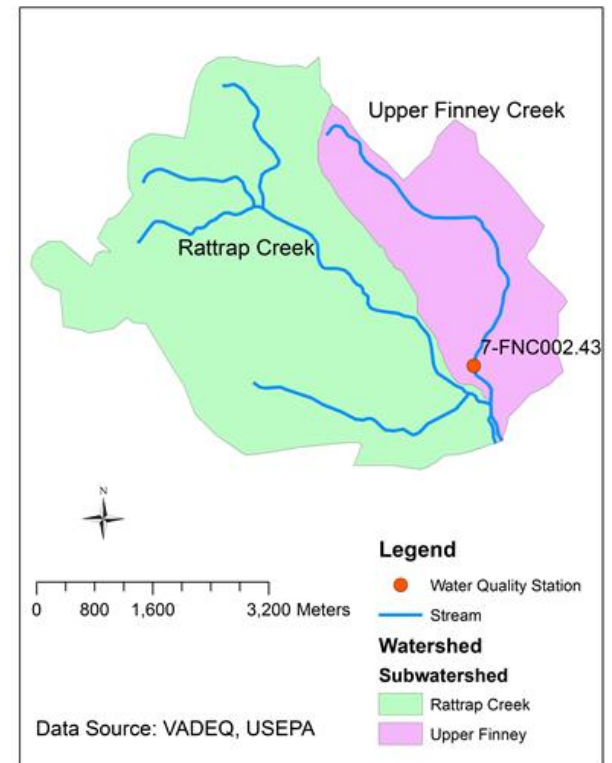
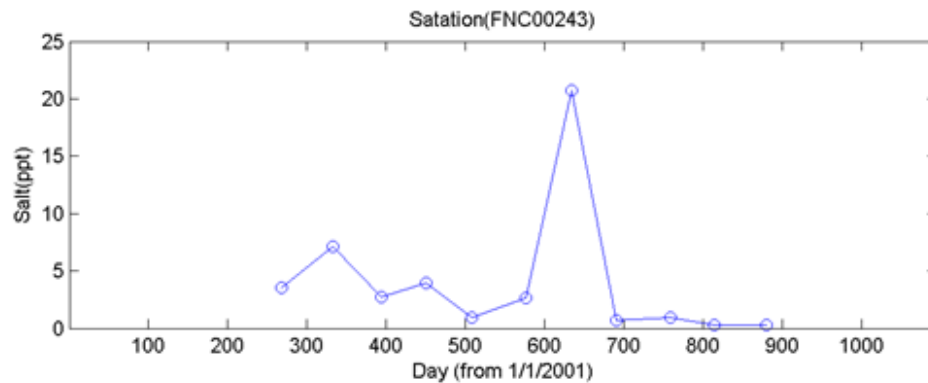
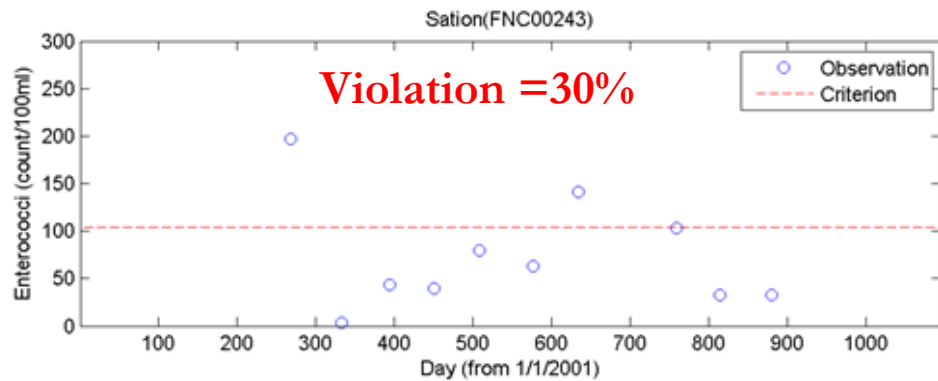
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Data Source: Virginia Department of the Environmental Quality Map Date: August 2011



Finney Creek



Procedures of Pollutant Source Assessment

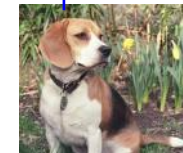
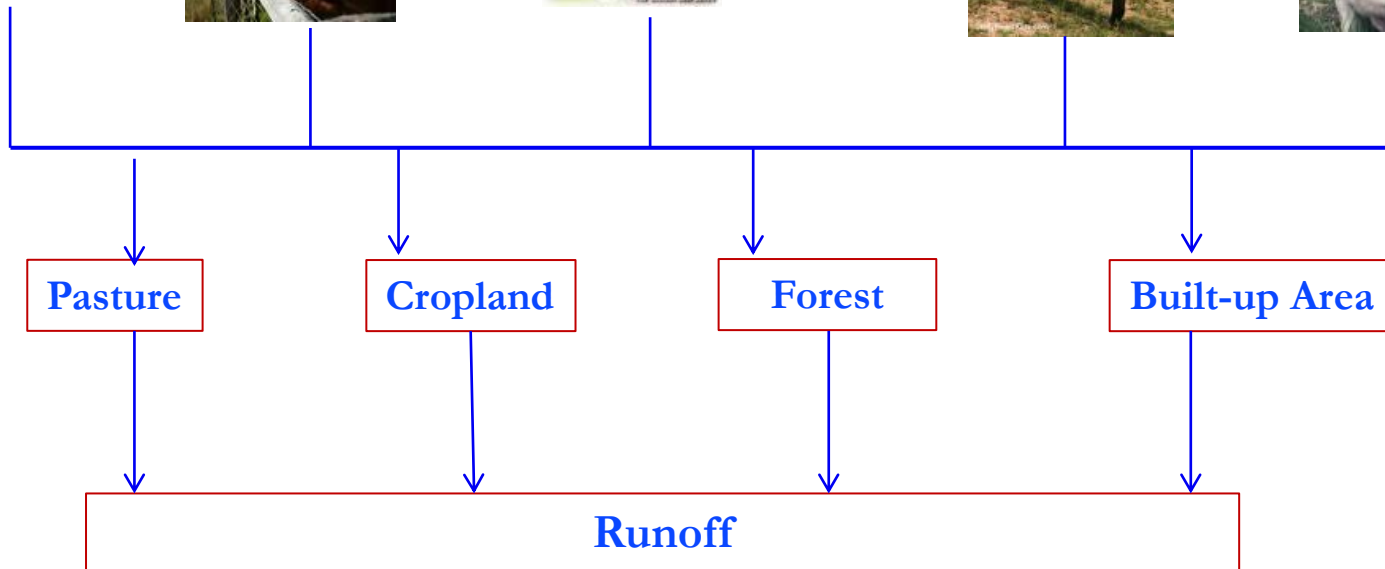
■ Sources

- Agricultural
- Humans
- Pets
- Livestock
- Wildlife

■ Approach

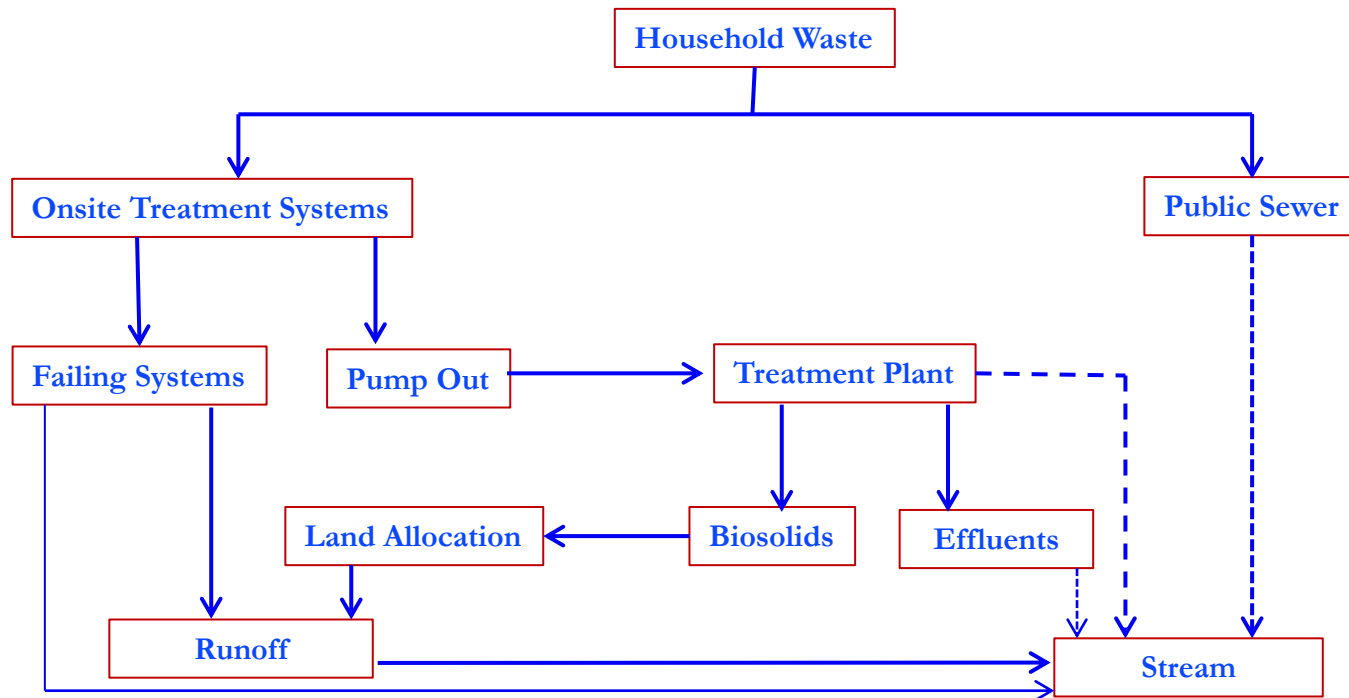
- GIS land use data (land use, population, pets, septic system)
- Wildlife survey data (animal density, animal habitat)
- Shoreline survey data
- Field survey
- Public meeting
- Interview

Potential Sources: Wildlife, Livestock, and Pets

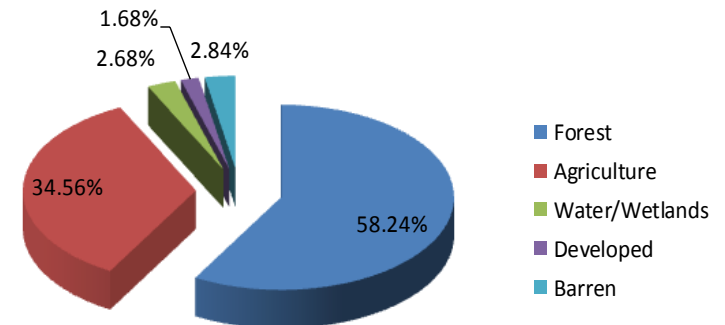
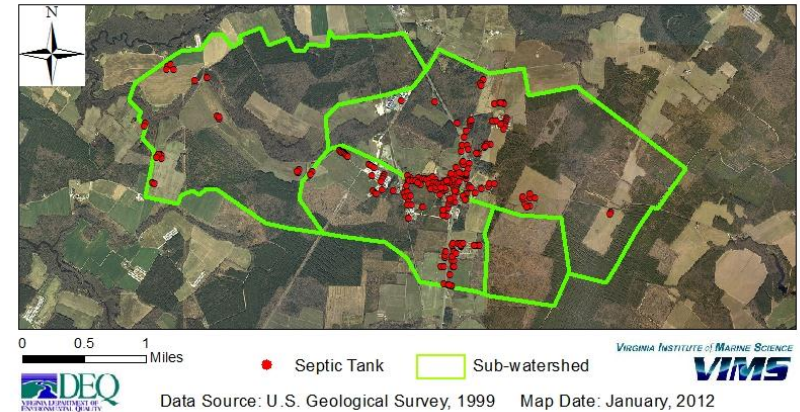
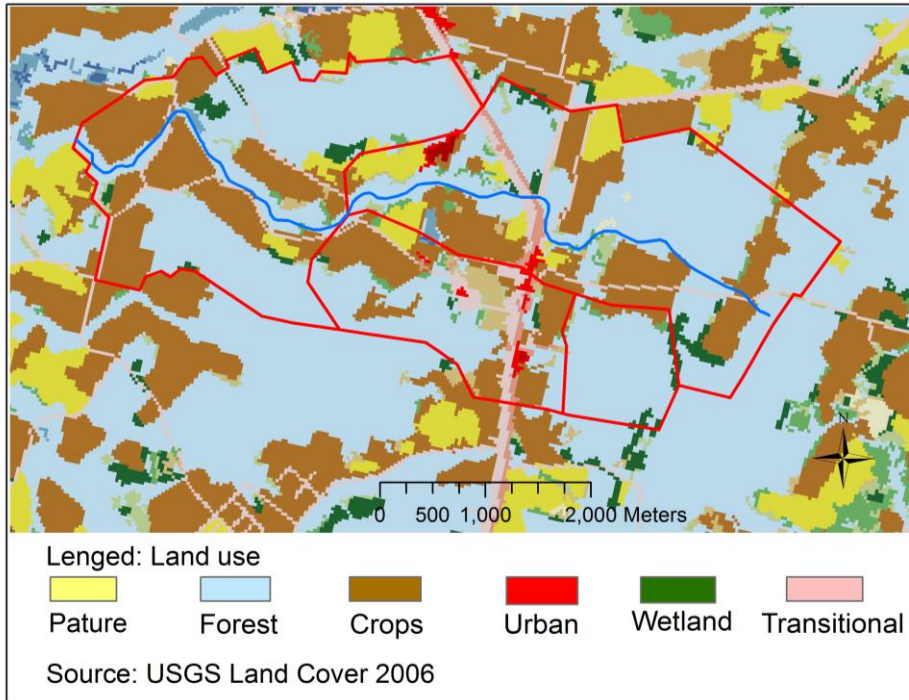


Source Assessment

Human Contribution (bacteria and nutrients)



Pitts Creek Loading Estimation



Pitts Creek Loading Estimation

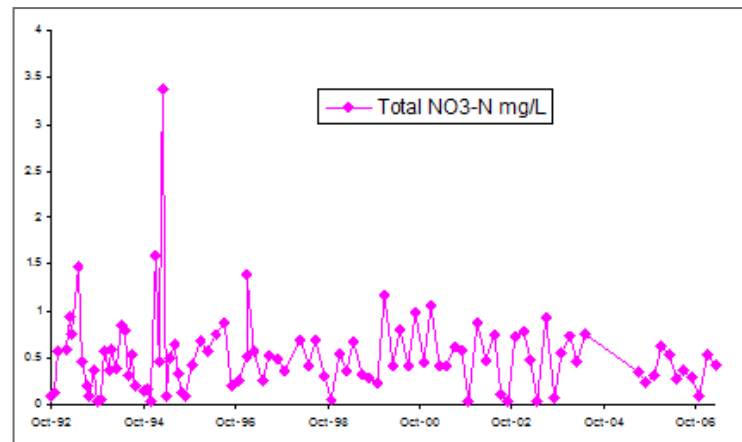
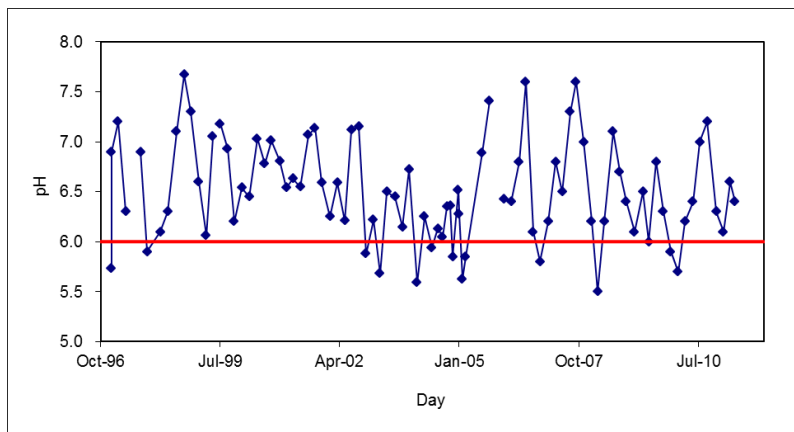
Sub-watershed		1	2	3	4
Human		185	211	37	85
Dog		43	49	9	20
Livestock	Cattle	3	2	<1	1
	Swine	7	7	<1	3
	Horse	1	1	<1	1
	Sheep	1	<1	<1	<1
	Chicken	29,280	28,132	1,776	11,124
Wildlife	Duck	19	21	4	9
	Geese	45	51	9	20
	Deer	50	54	9	21
	Raccoon	70	80	14	32

Manure application - 52 tons/year

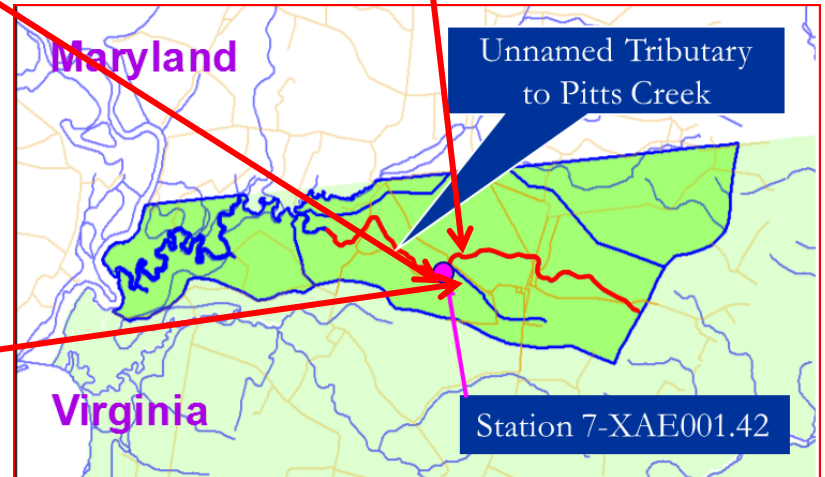
Fecal Coliform Source	Loading Counts/day	Loading Percent
Livestock	1.20E+12	15.48%
Wildlife	6.35E+12	82.06%
Human	5.95E+08	0.01%
Pet	1.90E+11	2.45%
Total	7.73E+12	100.00%

Natural Condition of Low pH

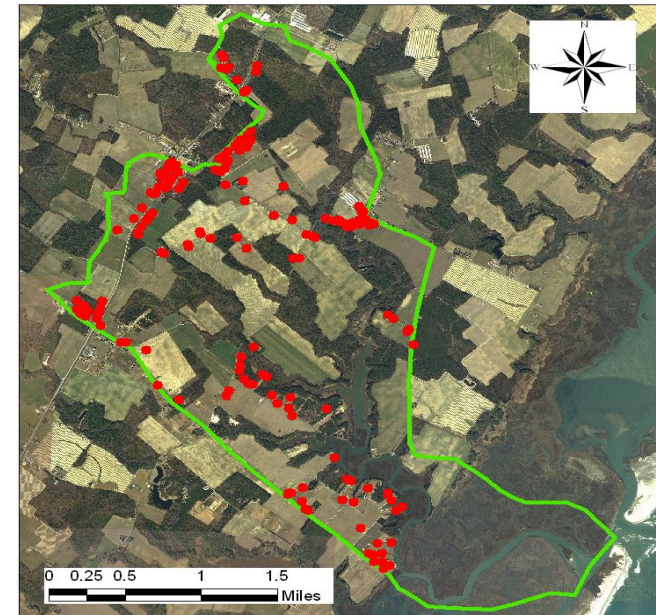
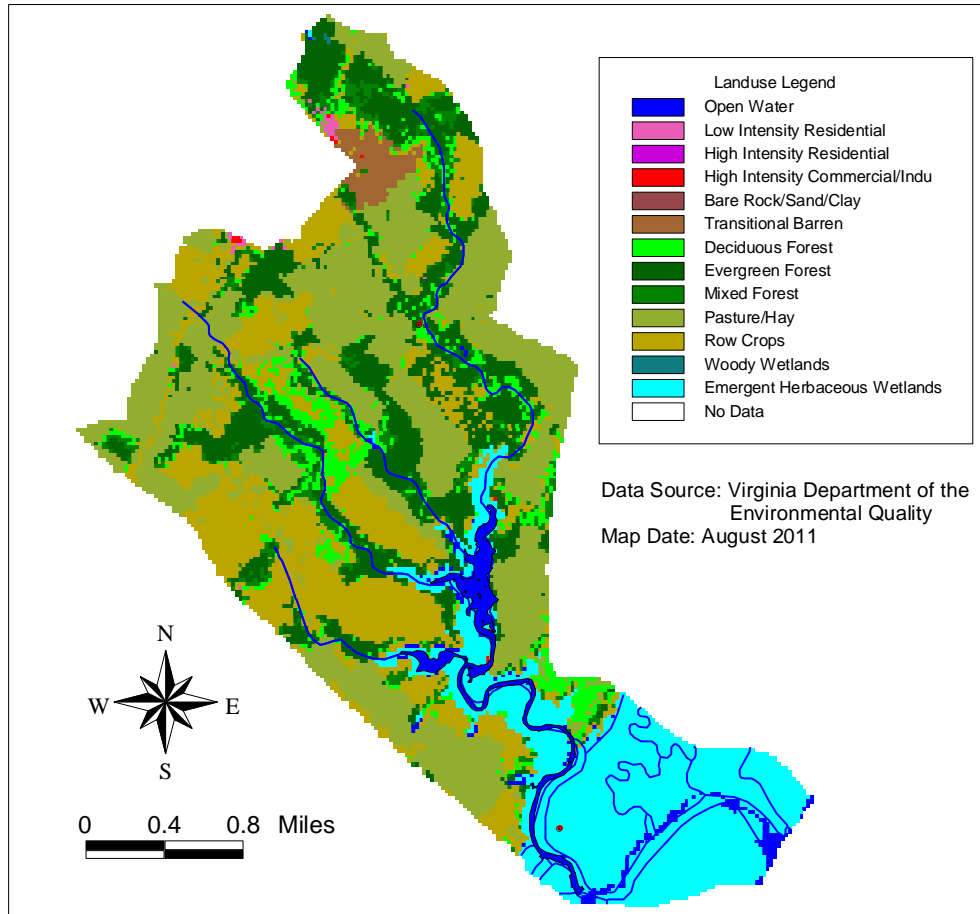
- Low pH occurs due to decay of vegetative materials (forest, marsh, wetland) to produce organic acids
- Conditions in a stream that would typically be associated with naturally low pH include slow-moving water, ripple-less waters
- These situations can be compounded by anthropogenic activities (excessive nutrients or pollutants)



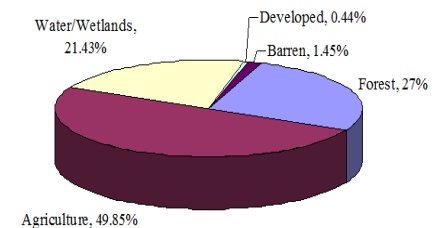
Pitts Creek



Gargathy Creek Loading Estimation



Legend: • Septic Tanks □ Gargathy Creek Watershed



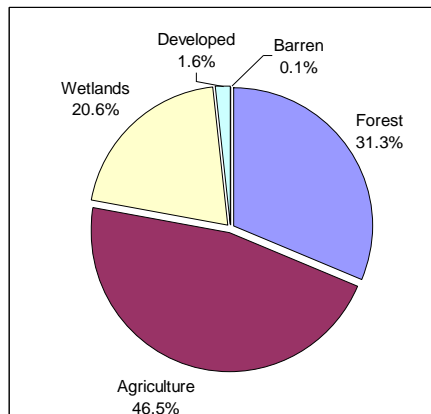
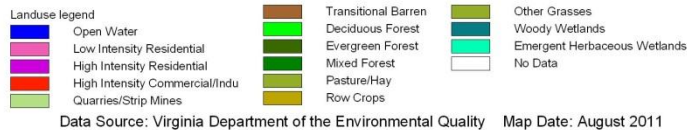
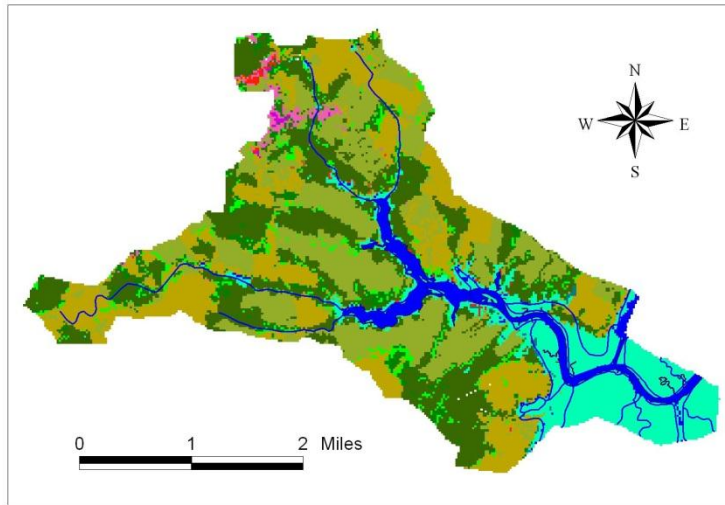
Gargathy Creek Loading Estimation

		Totals
Humans		494
Dogs		139
Cat**(unused)		157
Livestock	Cattle	12
	Swine	0
	Chickens	134390
	Horses	7
	Sheep	6
Wildlife	Ducks	9
	Geese	96
	Deer	200
	Raccoons	101
	Muskrat	361
	Nutria	212

Category	Source Allocation
Livestock	58.98%
Wildlife	39.49%
Human	0.01%
Pets	1.51%
Total	100.00%

Manure has been applied to about 49 acres of cropland based on CAFO inspection

Folly Creek Loading Estimation



Category		Totals
Human		717
Dog		202
Cat (Data Unused)		227
Livestock	Cattle	17
	Swine	0
	Chickens	207395
	Horses	9
	Sheep	7
	Ducks	13
Wildlife	Geese	139
	Deer	282
	Raccoons	129
	Muskrat	446
	Nutria	262

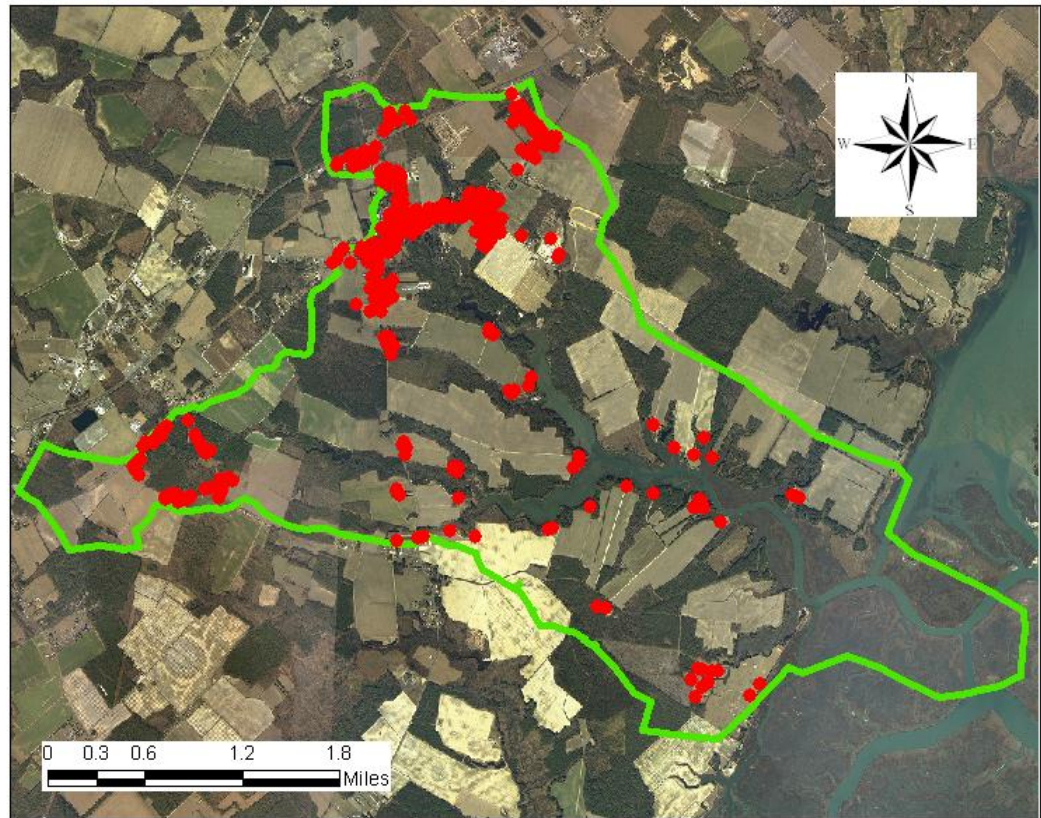
*Chicken total is estimated using land use data

Folly Creek Loading Estimation

Bacteria Sources

Category	Source Allocation
Livestock	25.52%
Wildlife	72.54%
Human	0.02%
Pets	1.92%
Total	100.00%

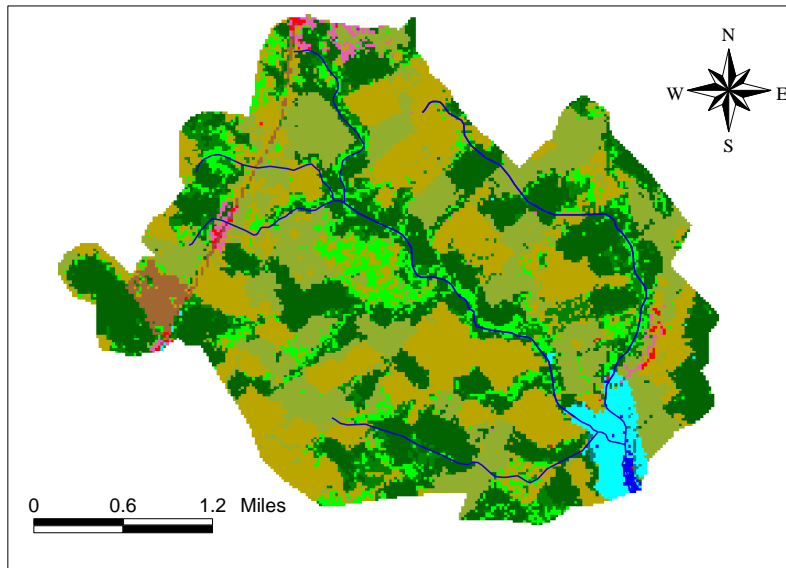
No manure application!



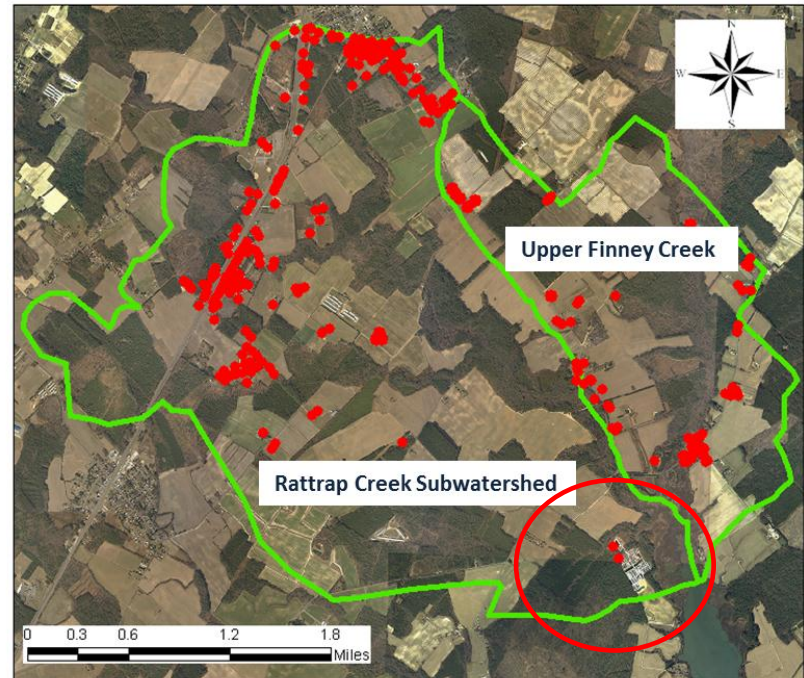
Legend: ● Septic Tanks □ Folly Creek Watershed
Data Source: U.S. Geological Survey. 1999 Map Date: Sep. 2011

Septic Tanks

Finney Creek Loading Estimation

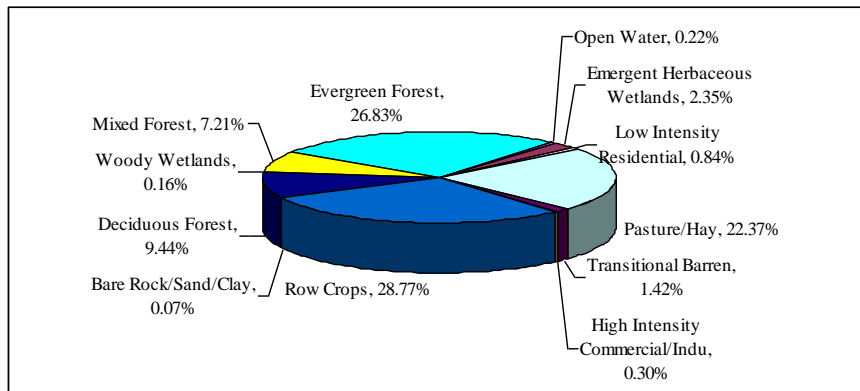


Data Source: Virginia Department of the Environmental Quality Map Date: August 2011



Legend: ● Septic Tanks □ Watershed

Data Source: U.S. Geological Survey. 1999 Map Date: Sep. 2011



Finney Creek

		Finney Creek watershed	Rattrap Creek watershed	Whole watershed
Humans		200	528	728
Dogs		56	149	205
Cat**(unused)		63	168	231
Livestock	Cattle	5	13	18
	Swine	0	0	0
	Chickens	64473	198926	263399
	Horses	3	5	8
	Sheep	2	5	7
Wildlife	Ducks	4	9	13
	Geese	40	101	141
	Deer	82	214	296
	Raccoons	34	81	115
	Muskrat	109	231	340
Nutria		64	136	200

Waterbody Name	Source	Percent of Source
Upper Finney Creek	Livestock	14.15%
	Wildlife	83.62%
	Human	0.03%
	Pets	2.21%
	Total	100.00%
Rattrap Creek	Livestock	26.57%
	Wildlife	71.51%
	Human	0.02%
	Pets	1.90%
	Total	100.00%

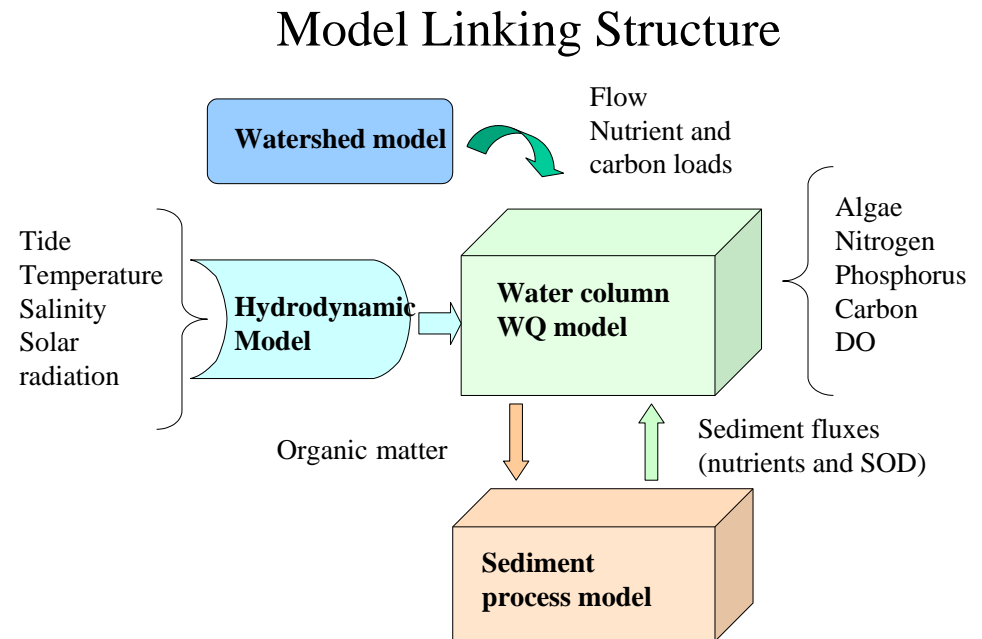
No manure application!

Other Nutrient Sources

- N-fertilizer applied to the cropland is 125 lb/acre/year
- Lawn fertilizer loading is 44 lbs/acre/year
- Nutrient contribution from atmospheric deposition
 - TN = 11.48 lb/acre/year
 - TP = 0.71 lb/acre/year

Modeling Approach

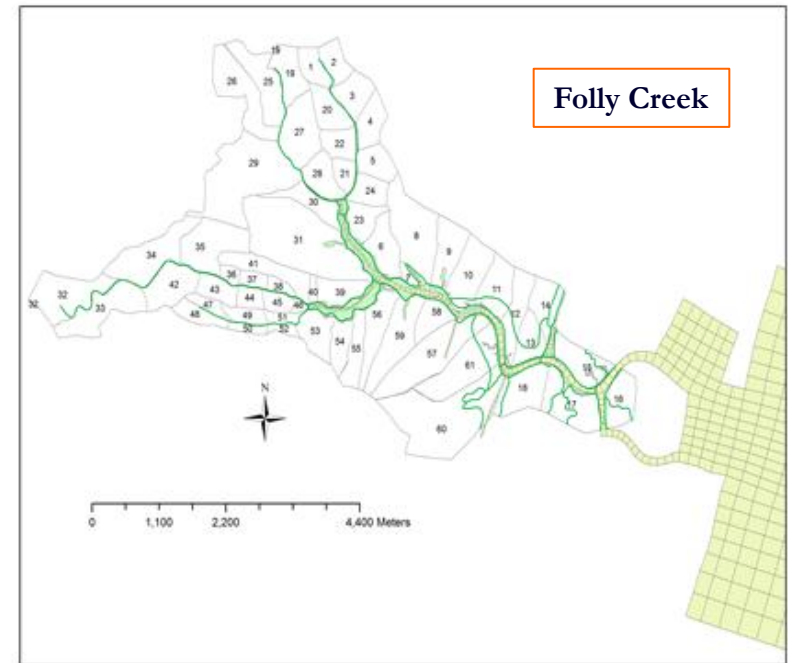
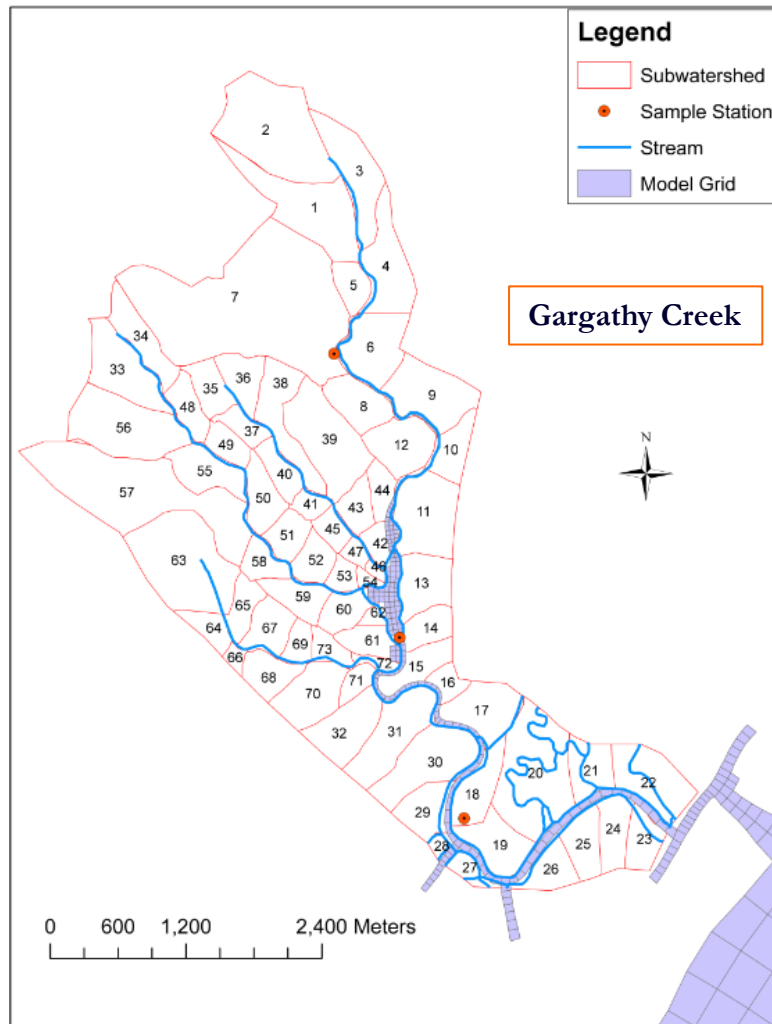
- Conduct source analysis
 - Estimate nutrients or bacteria sources
 - Use LSPC to simulate watershed processes
- Use a spatially varying water quality model (EFDC)
 - Simulate in-stream DO processes
 - Simulate bacteria transport and fate



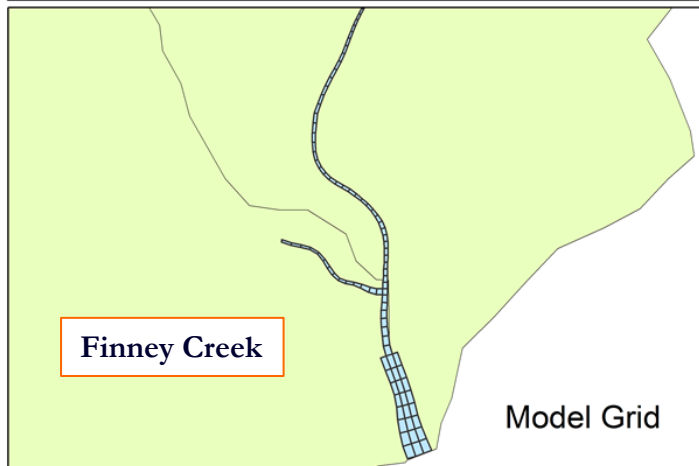
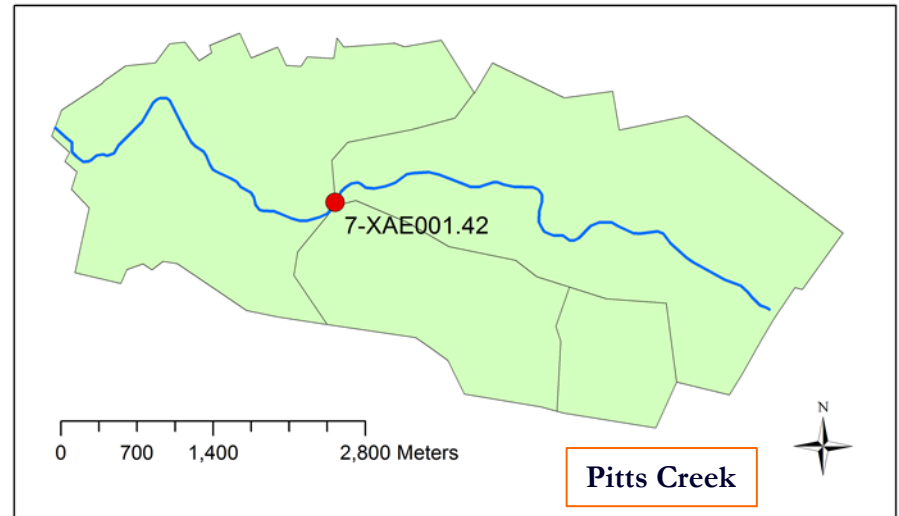
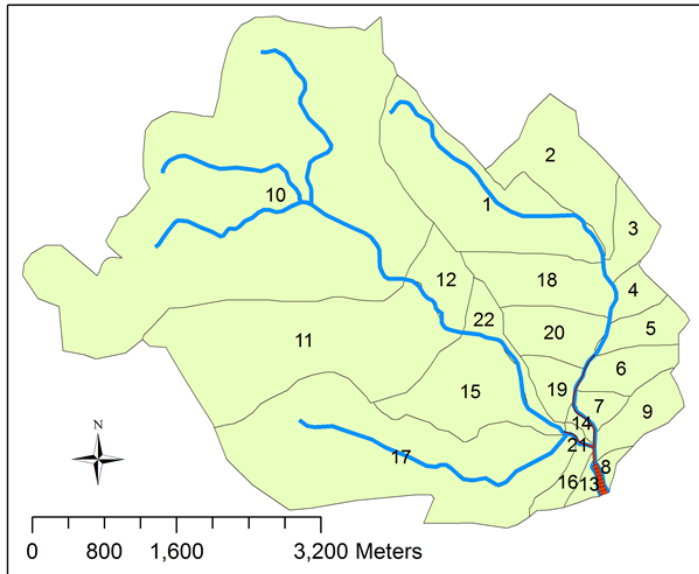
Model Simulation

- Watershed Segmentation
 - Simulation flow, loading using Loading Simulation Program C⁺⁺ (LSPC)
- Receiving water
 - grid generation
 - Simulate pollutant transport using Environmental Fluid Dynamic Computer Code (EFDC)
- Both models are supported by USEPA

Watershed Segmentation and Model Grid



Watershed Segmentation and Model Grid



TMDL Development

- Source analysis
- Use linked watershed and in-stream modeling approach
- Simulate daily nutrients and carbon loadings and bacteria loadings from watershed
- Discharge loads to in-stream model
- Use in-stream water quality model to simulate DO dynamics, and bacteria transport and fate
- Calibrate water quality model
- Compute allowable loads and determine load reduction

Preliminary Results of TMDLs

Pitts Creek

Bacteria	TMDL	=	LA	+	WLA	+	FA	+	MOS
<i>E. coli</i>	6.39×10^9		6.07×10^9		n/a		n/a		3.2×10^8

TMDL = Total Maximum Daily Load

LA = Load Allocation (nonpoint source)

WLA = Wasteload Allocation (Point source)

FA = Future Allocation

MOS = Margin of Safety

Category	Source Allocation	Current Load (Counts/Day)	Load Allocation (Counts/Day)	Required Reduction (%)
Livestock	15.48%	9.89E+09	0	100.00%
Wildlife	82.06%	5.24E+10	6.39E+09	87.81%
Human	0.01%	4.91E+06	0	100.00%
Pets	2.45%	1.57E+09	0	100.00%
Total	100.00%	6.39E+10	6.39E+09	90.00%

Gargathy Creek

Pollutant	Current Load (lb/day)	Allowable Load (lb/day)	Required Reduction (%)
TN	144.1	108.1	25

Pollutant	Criterion (counts/100ml)	Current Load (counts/day)	Allowable Load (counts/day)	Required Reduction (%)
E. coli	235	4.50×10^{10}	1.80×10^{10}	60

Category	Source Allocation	Current Load (Counts/Day)	Load Allocation (Counts/Day)	Required Reduction
Livestock	58.98%	2.65×10^{10}	2.30×10^8	99.14
Wildlife	39.49%	1.78×10^{10}	1.78×10^{10}	0.00
Human	0.01%	4.50×10^6	0	100.00
Pets	1.51%	6.80×10^8	0	100.00
Total	100.00%	4.50×10^{10}	1.80×10^{10}	60.00

Folly Creek

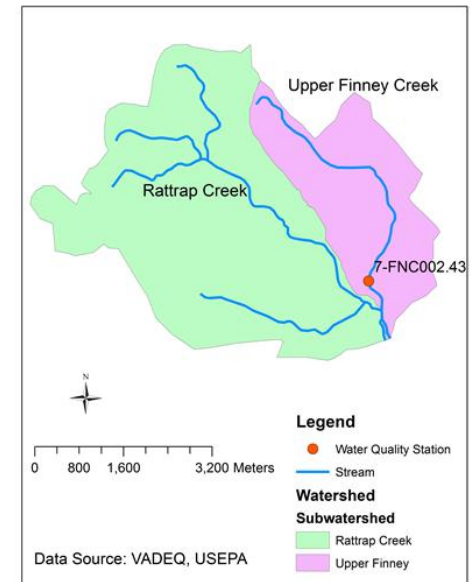
	TMDL	=	LA	+	WLA	+	FA	+	MOS (5%)
Total Nitrogen	151.2		143.7		n/a		n/a		7.6
Enterococci	2.43×10^{10}		2.31×10^{10}		n/a		n/a		1.12×10^9

Source	% of Source Distribution	Current Load (Counts/Day)	LA (Counts/Day)	Reduction Needed (%)
Livestock	25.52%	1.55E+10	0	100.0
Wildlife	72.54%	4.41E+10	2.43×10^{10}	44.9
Human	0.02%	1.40E+07	0	100.0
Pets	1.92%	1.17E+09	0	100.0
Total	100.00%	6.08E+10	2.43×10^{10}	60.0

Finney Creek

Waterbody Name		TMDL	=	LA	+	WLA	+	FA	+	MOS (5%)
Finney Creek	Enterococci	1.33×10^{10}		1.27×10^{10}		n/a		n/a		6.7×10^8
Rattrap Creek	Enterococci	3.33×10^{10}		3.16×10^{10}		n/a		n/a		1.7×10^9

Waterbody Name	Source	Current Load (Counts/Day)	LA (Counts/Day)	Reduction Needed (%)
Upper Finney Creek	Livestock	14.15%	0	100.0%
	Wildlife	83.62%	$1.33\text{E}+10$	76.1%
	Human	0.03%	0	100.0%
	Pets	2.21%	0	100.0%
	Total	100.00%	$1.33\text{E}+10$	80.0%
Rattrap Creek	Livestock	26.57%	0	100.0%
	Wildlife	71.51%	$3.33\text{E}+10$	72.0%
	Human	0.02%	0	100.0%
	Pets	1.90%	0	100.0%
	Total	100.00%	$3.33\text{E}+10$	80.0%



Questions and Comments

- Source estimation ?
- Loading estimation ?
- TMDL calculation ?
- Other questions/comments ?

Thanks!